BNWL-162

UC-2, General, Miscellaneous,
and Progress Reports

FIRST UNRESTRICTED

NOV 1 5 '65

DISTRIBUTION MADE

TID-4500

45 TH

EDITION

QUARTERLY PROGRESS REPORT
A STUDY OF TUNGSTEN-TECHNETIUM ALLOYS
JULY 1, 1965-OCTOBER 1, 1965

By

The Staff of Metallurgy Development Section
Reactor and Materials Technology Department

Sponsored by the National Aeronautics and Space Administration
Project Management at Washington, D. C.
J. W. Maltz, Office of Advanced Research and Technology

October, 1965

PACIFIC NORTHWEST LABORATORY
RICHLAND, WASHINGTON

Previous Quarterly Progress Reports in this series:

HW-83550	April 1, 1964 - July 1, 1964
HW-84309	July 1, 1964 - October 1, 1964
HW-84550	October 1, 1964 - January 1, 1965
BNWL-141	January 1, 1965 - April 1, 1965
BNWL-142	April 1, 1965 - July 1, 1965

Printed in USA. Price $1.00. Available from the
Clearinghouse for Federal Scientific and Technical Information,
National Bureau of Standards,
U. S. Department of Commerce,
Springfield, Virginia

QUARTERLY PROGRESS REPORT
A STUDY OF TUNGSTEN-TECHNETIUM ALLOYS
JULY 1, 1965 - OCTOBER 1, 1965

INTRODUCTION

Technetium is a sister element to rhenium and has many properties that are similar to rhenium. It is predicted that technetium will have about the same effects on tungsten as rhenium in regard to increase in workability, lowered ductile to brittle transition temperature, and improved ductility.

The objectives of the current work are to recover technetium from fission product wastes at Hanford and reduce to purified metal; prepare W-Tc alloys containing up to 50 at.% Tc; fabricate the alloy ingots to sheet stock, assessing the effect of technetium on workability; and perform metallurgical and mechanical property evaluation of the fabricated alloys.

Previous reports have described the separation and purification of 800 g of technetium metal powder, melting of technetium and W-Tc alloys, and some properties of the arc cast alloys.

CURRENT PROGRESS

During the past quarter remelting of the alloys was begun using a 10 kW electron beam evaporator unit in an effort to eliminate porosity observed in the arc cast material. In this unit the buttons are melted in a four-compartment water-cooled copper crucible at a pressure of approximately 5×10^{-7} Torr. Two pure tungsten and the 5, 10, 20, and 30 at.% Tc alloys were melted. During melting of the 30 at.% alloy burn through of the copper crucible occured, requiring complete clean up of the chamber and replacement of the crucible and parts of the electron gun assembly. This work was performed within a complete enclosure of the chamber and under fresh air mask radiation procedures due to the high technetium activity. The equipment is back in operation and several melts of a W–25 at.% Re alloy have been made to improve the melting technique. Well formed buttons with smooth, regular surfaces were made and radiographs of these revealed no internal porosity. The W-Tc alloys previously remelted were irregular in shape and would be difficult to fabricate, so will be melted again. Losses of approximately 3 g of the 30 to 35 g alloy buttons occurred and was due primarily to splatter during melting rather than to evaporation.

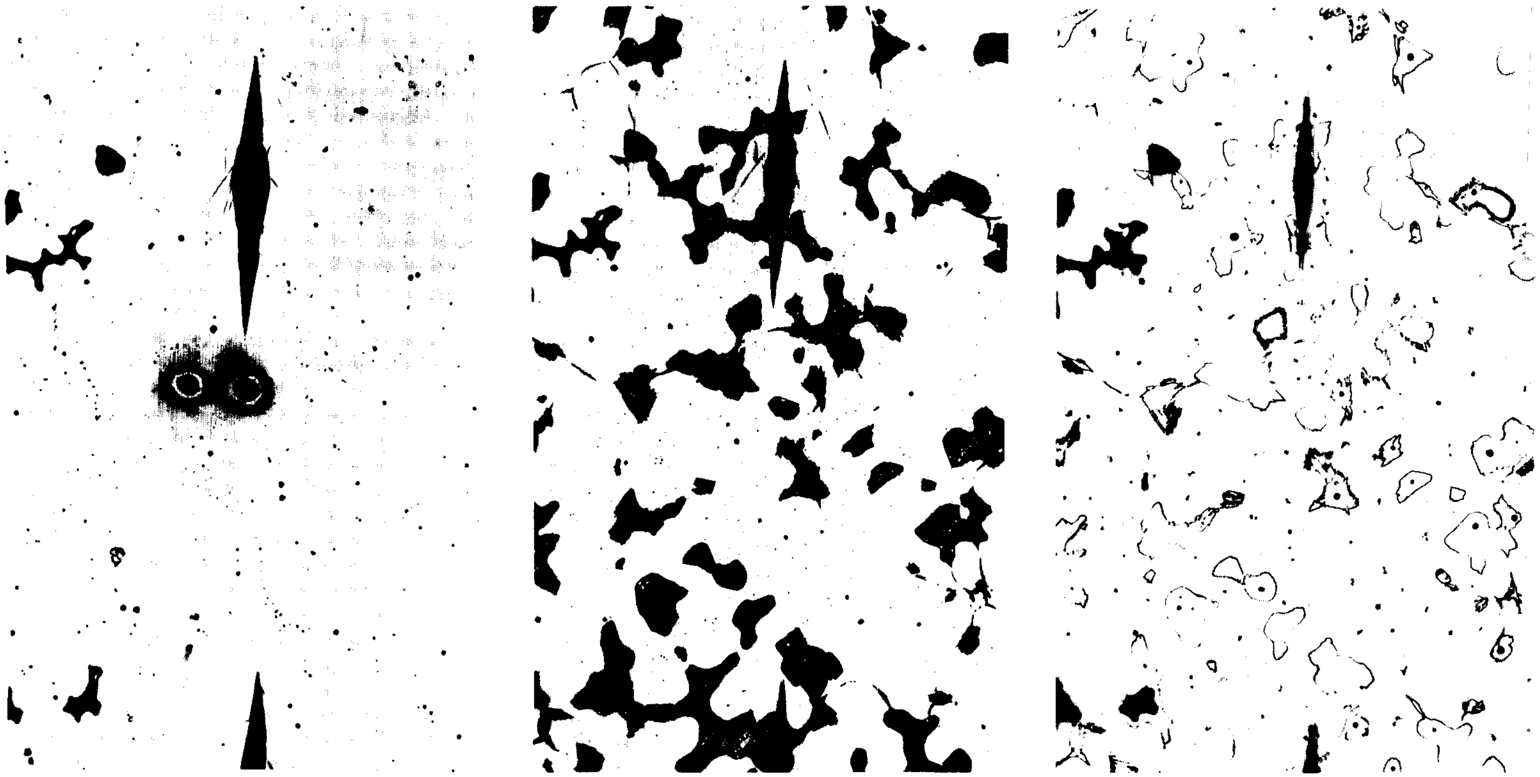
Arc melted alloys contained 50 at. % (35 wt%) and 60 at. % (45 wt%) Tc were examined with an electron beam microprobe* in attempts to determine compositions within the second phase regions of these alloys. Typical regions examined are shown in Figures 1 and 2 for the 50 at. % alloy and in Figures 3 and 4 for the 60 at. % alloy. Composition variations within the grain boundary areas (darkened) of the 50 at. % alloy or within the matrix areas of the 60 at. % alloy were not resolved to determine whether these areas were alpha plus sigma or single phase sigma. It was shown that this region was of higher average technetium content than the matrix in the 50 at. % alloy and that the matrix was of higher average technetium content than the dendritic second phase of the 60 at. % alloy. The composition of the dendritic second phase shown in Figures 3 and 4 was determined to be 38 wt% Tc, which is in good agreement with the maximum solubility of technetium in tungsten determined from lattice parameter measurements of the as cast alloys. The average matrix composition was determined to be 49 to 50 wt% Tc which is less than sigma composition (58 to 60 wt% Tc). These measurements together with observations of the structure, indicate that the nonequilibrium structure of both alloys is alpha solid solution plus a region of alpha and sigma. The configuration of this second region appears eutectic and it is the last region to freeze. This interpretation would place the 60 at. % Tc alloy as hypoeutectic.

Literature Review

No additional information pertaining to technetium alloys was noted during this reporting period.

---

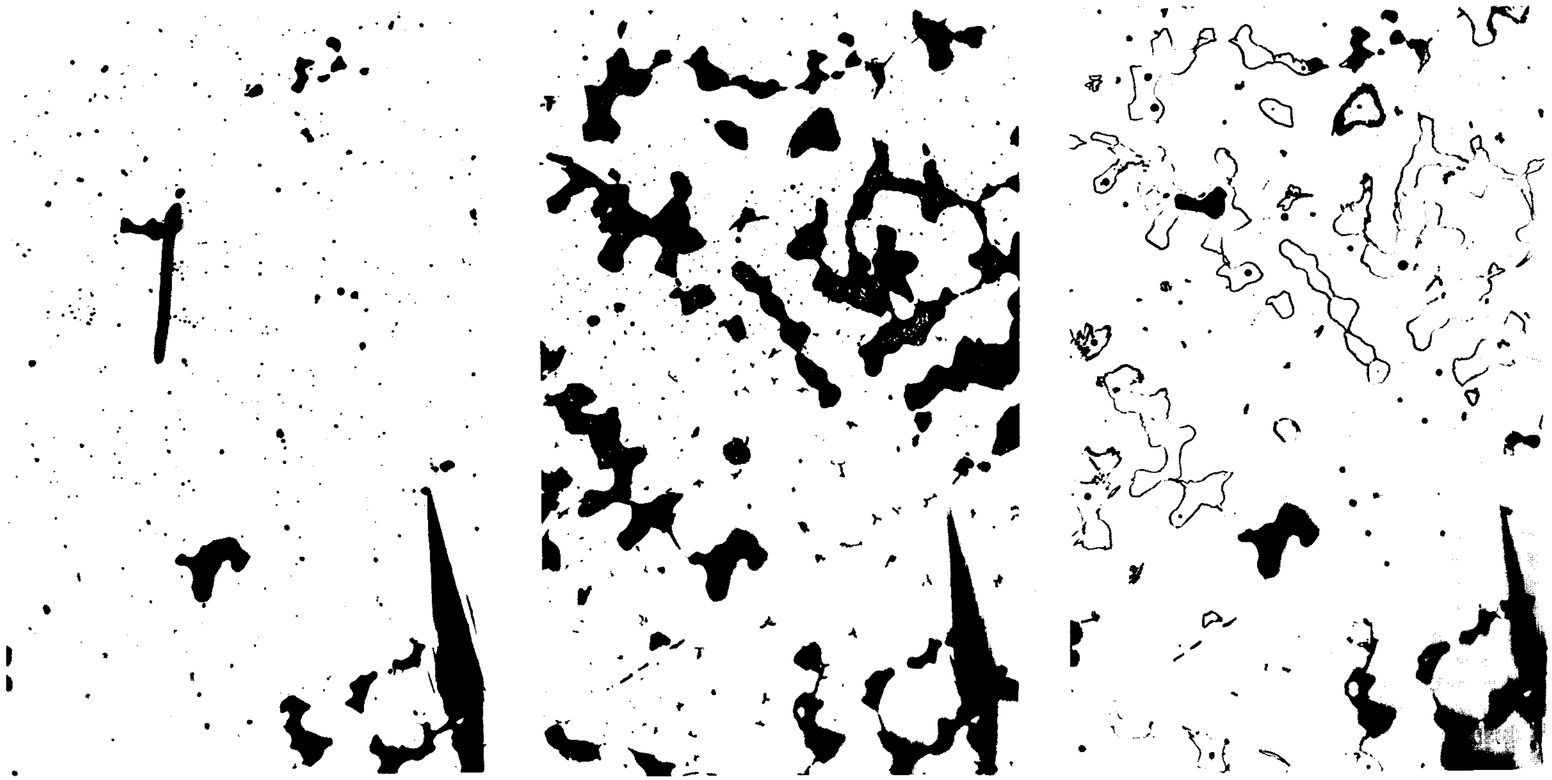
* Work performed by W. F. Selezny, Phillips Petroleum Co., Idaho Falls, Idaho.



As-Examined | Etched with Murakami's Etch | Further Etch with NaOH Etch

FIGURE 1

Location of Microprobe Analysis
W–50 at. % Tc Alloy
250X



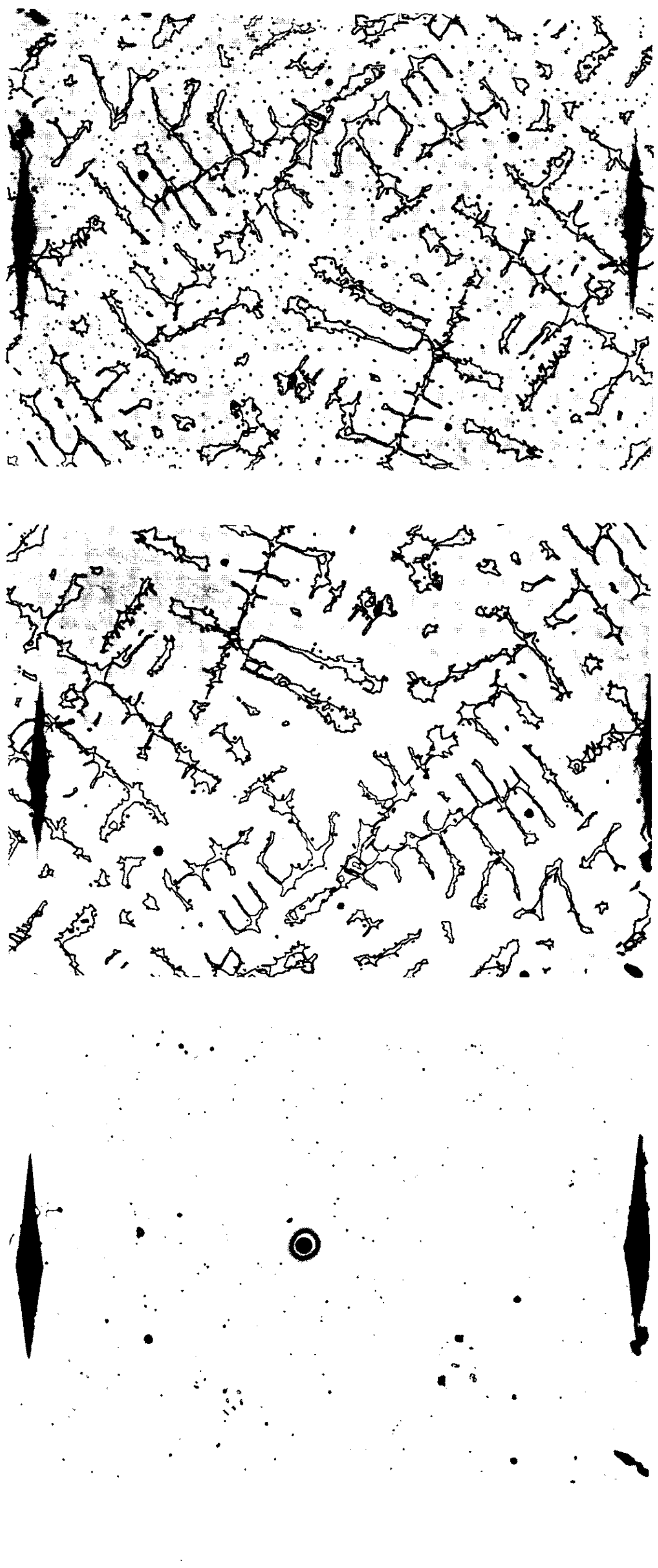
As-Examined

Etched with Murakami's Etch

Further Etch with NaOH Etch

FIGURE 2

Location of Microprobe Trace
W–50 at. % Tc Alloy
250X



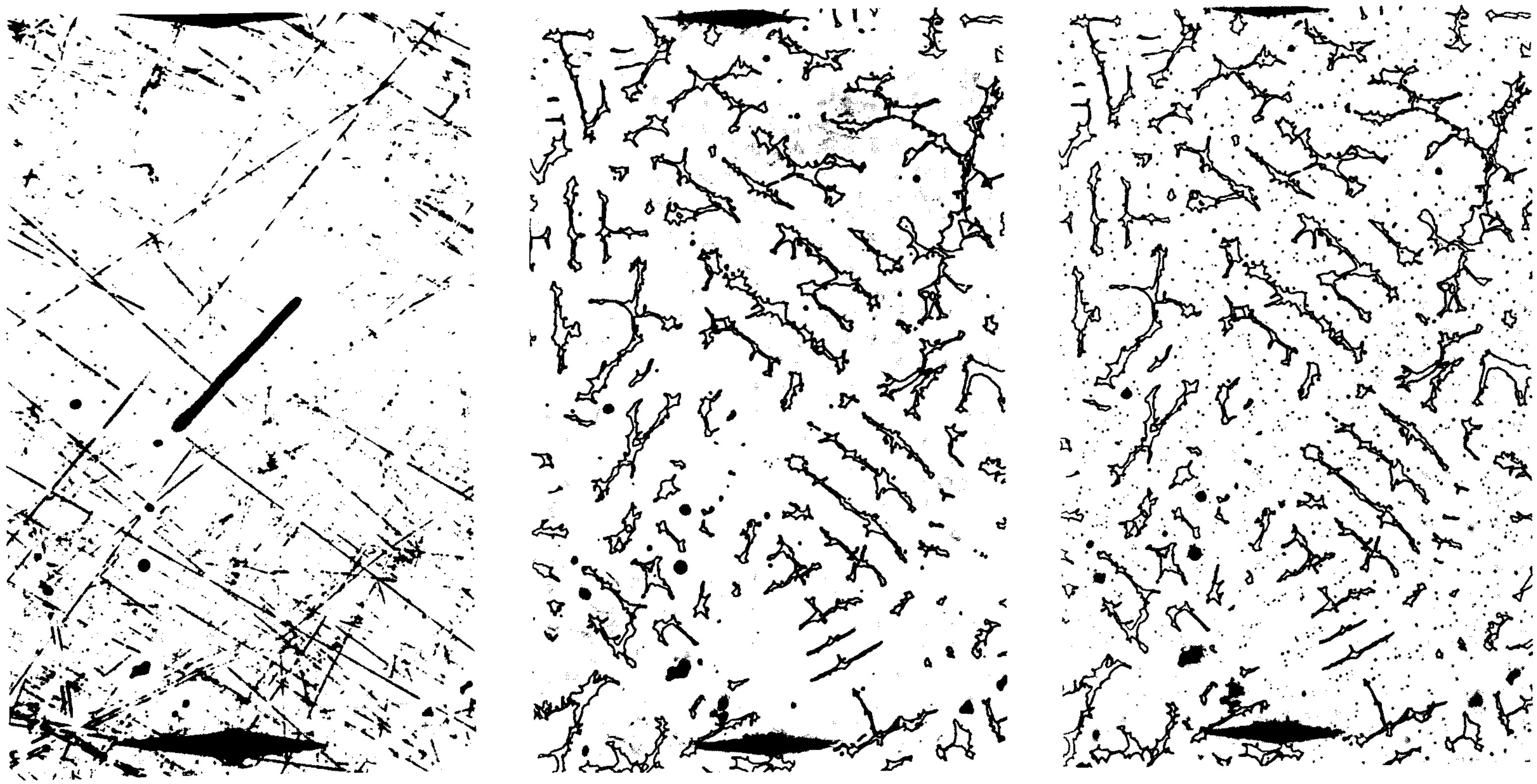
As-Examined

Etched with Murakami's Etch

Further Etch with NaOH Etch

FIGURE 3

Location of Microprobe Analysis
W–50 at. % Tc Alloy
250X



As-Examined | Etched with Murakami's Etch | Further Etch with NaOH Etch

FIGURE 4

Location of Microprobe Trace
W–60 at. % Tc Alloy
250X

ONSITE DISTRIBUTION

Copy Number	Pacific Northwest Laboratory
1	F. W. Albaugh
2	S. H. Bush
3	J. J. Cadwell
4	D. R. deHalas
5	L. A. Hartcorn
6	R. N. Johnson
7	R. S. Kemper
8	G. A. Last
9 - 18	J. E. Minor
19	R. L. Moore
20	R. G. Moore
21	D. P. O'Keefe
22	F. P. Roberts
23	R. H. Todd
24	M. T. Walling
25 - 26	O. J. Wick
27	F. W. Woodfield
28 - 32	Technical Information Files
33	300 Area Technical Publications
34 - 35	700 Area Technical Publications
	General Electric Company
36	GETA File Copy
	Richland Operations Office
37	P. G. Holsted
38	R. K. Sharp
39	Technical Information Library

OFFSITE DISTRIBUTION (SPECIAL)

No. of Copies	
1	Army Materials Research Agency Attn: S. V. Arnold
2	Atomic Energy Commission, Washington Division of Reactor Development and Technology (1) Attn: K. Horton (1)
2	Battelle Memorial Institute Defense Metals Information Center (1) Attn: R. I. Jaffee (1)

OFFSITE DISTRIBUTION (SPECIAL) (contd)

No. of Copies	
3	Bureau of Mines Department of Interior Washington, D. C. Attn: R. F. Stevens, Jr., Commodity Specialist
1	Bureau of Naval Weapons Department of Navy Washington, D. C. 20546 Attn: T. F. Kearns, RRMA-2
1	Chicago Patent Group
1	Climax Molybdenum Company of Michigan 14419 Woodrow Wilson Detroit 38, Michigan Attn: M. Semchyschen
1	General Electric Company Research Laboratory P. O. Box 1088 Schenectady, New York Attn: Walter Hubbard
4	General Electric Company, Cincinnati Attn: L. P. Jahnke, (1) Advanced Engine Technology Department J. A. McGurty (1) E. D. Sayre, APED (1) C. S. Wukusick (1)
1	General Electric Company Lamp Metal Component Department Cleveland, Ohio Attn: J. H. Keeler
1	General Telephone and Electronics Laboratories, Inc. Bayside 60, New York Attn: L. L. Seigle
1	Jet Propulsion Laboratory Attn: H. Martens, Engineering Mechanics Division
1	NASA Ames Research Center Attn: Charles A. Hermach Vehicle Environment Division
1	NASA Goddard Space Flight Center Attn: H. E. Frankel Spacecraft Systems Division

OFFSITE DISTRIBUTION (SPECIAL) (contd)

No. of Copies	
1	NASA Langley Research Center Attn: E. E. Mathauser Structures Research Division
2	NASA Lewis Research Center Attn: W. D. Klopp, 105-1 N. Saunders, M&S Division
1	NASA Manned Spacecraft Center Attn: R. L. Johnston, S&M Division
1	NASA Marshall Space Flight Center Attn: W. R. Lucas, R-P&VE-M
2	National Aeronautics and Space Administration 600 Independence Avenue S. W. Washington, D. C. 20546 Attn: Joseph Maltz, Code RRM
2	National Aeronatucs and Space Administration Universal North Building Washington, D. C. 20546 Attn: Office of Grants & Research Contracts, Code SC
1	Union Carbide Corporation (ORNL) Attn: M. L. Picklesimer, Metals and Ceramics
1	Universal-Cyclops Steel Corporation Bridgeville, Pennsylvania Attn: C. P. Mueller
1	Westinghouse Electric Corporation Research Laboratory Churchill Boro Pittsburgh 35, Pennsylvania Attn: J. H. Bechtold
1	Wright-Patterson Air Force Base, Dayton, Ohio Materials Laboratory Attn: K. Elbaum